who will hold at least a Bachelor degree, will be matched by a corresponding transformation of the labour market.

74. The question of subgroup projections for the United Kingdom was discussed. Even though not incorporated in the current presentation it is planned for the future. The correlation structure between projections of subgroups will need particular attention.

L. Round table discussion on "Is it necessary, and to what extent, to incorporate "feedback mechanisms" in demographic projections, in particular in population projections?"

75. In general, all panellists agreed that feedback mechanisms should be incorporated in demographic projections. This would provide a way to use existing knowledge and expertise from different fields related to demographic projections.

76. Feedback mechanisms are often already incorporated in population projection models, but this could be done more explicitly. For instance, the feedback effect of immigration (particularly from countries outside the European Union) on fertility and mortality should be taken into account in population projections. This would result in combining the fertility, mortality and migration components in a dynamic way.

77. Concerning the mechanisms that determine the evolution of mortality, lifestyles (i.e. smoking) , health care, and prevention are important. However, the population structure by education and social class is also important, and represents one of the factors behind the increase in life expectancy experienced in many countries.

78. In some cases there is a need for research and further knowledge about feedback mechanisms, like for the impact of the possible increase in retirement age. There is a need to increase the contribution from experts, in particular non-demographers, to the projection exercises. It was also noted that when feedback mechanisms are incorporated in population projections, the end results may be quite different from the initial expectations.

III. CONCLUSIONS

79. The participants recommended that the next meeting take place in three years time (Spring 2013) to discuss the following topics:

(a) Forecasting demographic components: Mortality (assumptions and methods);

(b) Forecasting demographic components: Fertility (assumptions and methods);

(c) Forecasting demographic components: Migration (assumptions and methods);

(d) Small population and sub-national population projections;

(e) Beyond population projections by age and sex;

(f) Stochastic techniques for demographic projections;

(g) The role of users of population projections;

(h) New approaches for forecasting components of projections, including behavioural models;

(i) Data quality;

(j) Micro-simulations.

80. The participants expressed their great appreciation to Statistics Portugal for hosting this meeting and providing excellent facilities for their work.

IV. FURTHER INFORMATION

81. All background documents and presentations for the meeting are available on the website of the UNECE Statistical Division.

V. ADOPTION OF THE REPORT

82. The present report of the meeting was adopted during the closing session.

eurostat
Methodologies and
Working papers

Work session on demographic projections

Lisbon, 28-30 April 2010

2010 edition

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EUROPEAN COMMISSION

ECONOMIC COMMISSION FOR EUROPE

EUROSTAT
(THE STATISTICAL OFFICE OF THE EUROPEAN UNION)

CONFERENCE OF EUROPEAN STATISTICIANS

Joint Eurostat-UNECE Work Session on Demographic Projections

Lisbon (Portugal) 28-30 April 2010

AGENDA AND TIMETABLE

The meeting will be held at Statistics Portugal/Instituto Nacional de Estatística (INE), Lisbon, starting on 28 April 2010, at 10:00 a.m

SUMMARY OF AGENDA ITEMS

1. Opening of the work session
2. Key note lectures
3. Challenges and use of demographic projections
4. Constructing assumptions for Mortality: data, methods and analysis
5. Constructing assumptions for Fertility: data, methods and analysis
6. Forecasting demographic components: Fertility
7. Forecasting demographic components: Mortality
8. Constructing assumptions for Migration: data, methods and analysis
9. Forecasting demographic components: Migration
10. Small population and sub-national population projections
11. Beyond population projections by age and sex
12. Stochastic techniques for demographic projections
13. Stochastic national demographic projections
14. Round table discussion
15. Proposals for future work
16. Adoption of the report

TIMETABLE

Time	Item	Session/Activity
DAY 1 – WEDNESDAY 28 April 2010		
– CONFERENCE ROOM 1 –		
10:00-10:30	Registration of participants	
10:30-11:00	1	**OPENING OF THE WORK SESSION**
		Welcome, adoption of the agenda and election of chair **Alda de Caetano Carvalho** – Statistics Portugal **Inna Šteinbuka** – European Commission, Eurostat **Paolo Valente** – United Nations Economic Commission for Europe (UNECE)
11:00-12:30 2		**KEY NOTE LECTURES**
11:00-11:45 2.	1	♦ Regional population change and cohesion policy ***Ronald Hall*** *– European Commission, Directorate General for Regional Policy (DG REGIO)*
11:45-12:30 2.	2	♦ Demographic changes, demographic projections ***Maria Filomena Mendes*** *– Portuguese Demographic Association*
14:00-15:30 3		**CHALLENGES AND USE OF POPULATION PROJECTIONS** **Chair: Vanda Cunha** – Ministry of Finance and Public Administration, Portugal
14:00-14:20 3.	1	♦ INE-Spain strategy on population estimates and projections: facing the challenge of the statistical measure of population ***Miguel Ángel Martínez Vidal, Sixto Muriel de la Riva*** *– National Statistics Institute of Spain*
14:20-14:40 3.	2	♦ Making use of long-term demographic projections in multilateral policy coordination in the European Union ***Giuseppe Carone, Per Eckefeldt*** *– Directorate General for Economic and Financial Affairs of the European Commission (DG ECFIN)*
14:40-15:00 3.	3	♦ Essay on ageing and health projections in Portugal ***Filipa Castro Henriques, Teresa Ferreira Rodrigues*** *– Universidade Nova de Lisboa, Portugal*
Paper not presented	3.4	♦ Current status and future challenges of the national population projection in South Korea concerning super-low fertility patterns: a case study through international comparison ***Kwang-Hee Jun*** *– Chungnam National University, Republic of Korea* ***Seulki Choi*** *– Seoul National University, Republic of Korea*
15:00-15:30		Questions & Discussion
16:00-17:30 4		**CONSTRUCTING ASSUMPTIONS FOR MORTALITY: DATA, METHODS AND ANALYSIS** **Chair: Graziella Caselli** – University of Rome "La Sapienza", Italy
16:00-16:20 4.	1	♦ Cohort and period mortality in Sweden in a very long perspective and projection strategies ***Hans Lundström*** *– Statistics Sweden*

Time	Item	Session/Activity
16:20-16:40 4.	2	♦ Increasing longevity and decreasing gender mortality differentials: new perspectives from a study on Italian cohorts ***Graziella Caselli*** – *University of Rome "La Sapienza", Italy* ***Marco Marsili*** – *ISTAT - Istituto Nazionale di Statistica, Italy*
16:40-17:00 4.	3	♦ Towards advanced methods for computing life tables ***Sixto Muriel de la Riva, Margarita Cantalapiedra Malaguilla, Federico López Carrión*** – *National Statistics Institute of Spain*
17:10-17:30		Questions & Discussion
		– CONFERENCE ROOM 2 –
14:00-15:30 5		**CONSTRUCTING ASSUMPTIONS FOR FERTILITY: DATA, METHODS AND ANALYSIS** **Chair: Maria Filomena Mendes** – Portuguese Demographic Association
14:00-14:20 5.	1	♦ Trend reversal in childlessness in Sweden ***Lotta Persson*** – *Statistics Sweden*
14:20-14:40 5.	2	♦ Is fertility converging across the Member States of the European Union? ***Giampaolo Lanzieri*** – *European Commission, Statistical Office of the European Union (Eurostat)*
14:40-15:00 5.	3	♦ Explanations for regional fertility reversal after 2005 in Japan: demographic, socio-economic and cultural factors ***Miho Iwasawa, Ryuichi Kaneko*** – *National Institute of Population and Social Security Research, Tokyo, Japan*
15:00-15:30		Questions & Discussion
16:00-17:30 6		**FORECASTING DEMOGRAPHIC COMPONENTS: FERTILITY** **Chair: Maria Filomena Mendes** – Portuguese Demographic Association
16:00-16:20 6.	1	♦A probabilistic version of the United Nations World Population Prospects: methodological improvements by using Bayesian fertility and mortality projections ***Gerhard K. Heilig, Thomas Buettner, Nan Li, Patrick Gerland, Francois Pelletier*** – *United Nations Population Division* ***Leontine Alkema*** – *National University of Singapore* ***Jennifer Chunn, Hana Ševčíková, Adrian Raftery*** - *University of Washington, USA*
16:20-16:40 6.	2	♦ Applying a fertility projection system to period effect analysis: an examination of the recent fertility upturn in Japan ***Ryuichi Kaneko*** – *National Institute of Population and Social Security Research, Tokyo, Japan*
16:40-17:00 6.	3	♦ Forecasting the number of births in Portugal ***António Caleiro*** – *Universidade de Évora, Portugal*
17:00-17:30		Questions & Discussion
		END OF DAY 1

Time	Item	Session/Activity
		DAY 2 – THURSDAY 29 April 2010
		– CONFERENCE ROOM 1 –
9:30-10:00 4		**CONSTRUCTING ASSUMPTIONS FOR MORTALITY: DATA, METHODS AND ANALYSIS (continued)** **Chair: Graziella Caselli** – University of Rome "La Sapienza", Italy
9:30-9:50	4.4	♦ Estimating life expectancy in small population areas ***Jorge Miguel Bravo*** *– Universidade de Évora, Portugal* ***Joana Malta*** *– Statistics Portugal*
9:5-10:00		Questions & Discussion
10:00-12:00 7		**FORECASTING DEMOGRAPHIC COMPONENTS: MORTALITY** **Chair: Graziella Caselli** - University of Rome "La Sapienza", Italy
10:00-10:20 7.	1	♦ Application of age-transformation approaches to mortality projection for Japan ***Futoshi Ishii*** *– National Institute of Population and Social Security Research, Tokyo, Japan*
10:20-10:40 7.	2	♦ Lee-Carter mortality projection with "Limit Life Table" ***Jorge Miguel Bravo*** *– University of Évora, Portugal*
10:40-11:00		Questions & Discussion
11:30-11:50 7.	3	♦ Mortality projections in Portugal ***Edviges Coelho, Maria da Graça Magalhães*** *- Statistics Portugal* ***Jorge Miguel Bravo*** *- University of Évora, Portugal*
11:50-12:00		Questions & Discussion
12:00-14:30 8		**CONSTRUCTING ASSUMPTIONS FOR MIGRATION: DATA, METHODS AND ANALYSIS** **Chair: Michel Poulain** – Université Catholique de Louvain, Belgium
12:00-12:20 8.	1	♦ International migration data as input for population projections ***Anne Herm, Michel Poulain*** *– Estonian Interuniversity Population Research Centre and Université Catholique de Louvain, Belgium*
12:20-12:30		Questions & Discussion
14:00-14:20 8.	2	♦ Prospective immigration to Israel through 2030: methodological issues and challenges ***Sofia Phren, Nitzan Peri*** *– Central Bureau of Statistics, Israel*
14:20-14:30		Questions & Discussion
14:30-17:00 9		**FORECASTING DEMOGRAPHIC COMPONENTS: MIGRATION** **Chair: Michel Poulain** – Université Catholique de Louvain, Belgium
14:30-14:50 9.	1	♦ Dealing with uncertainty in international migration predictions: from probabilistic forecasting to decision analysis ***Jakub Bijak*** *– University of Southampton, United Kingdom*
14:50-15:10 9.	2	♦ Model to forecast the re-immigration of Swedish-born persons ***Christian Skarman, Stina Andersson, Anders Ljungberg*** *– Statistics Sweden*
15:10-15:30		Questions & Discussion
16:00-16:20	9.3	♦ The role of social networks in the projection of international migration flows: an Agent-Based approach ***Carla Anjos*** *– University of Aveiro, Portugal* ***Pedro Campos*** *– Statistics Portugal and University of Porto, Portugal*

Time	Item	Session/Activity
16:20-16:40	9.4	♦ Forecasting migration flows to and from Norway using an econometric model ***Helge Brunborg, Ådne Cappelen*** – *Statistics Norway*
16:40-17:00		Questions & Discussion
		– CONFERENCE ROOM 2 –
9:30-12:00 10		**SMALL POPULATION AND SUB-NATIONAL POPULATION PROJECTIONS** **Chair: João Peixoto** - Universidade Técnica de Lisboa, Portugal
9:30-9:50 10	.1	♦ How to deal with sub-national forecasts in spatially very heterogeneous countries? Towards using some spatial theories and models ***Branislav Bleha*** – *Comenius University, Bratislava, Slovakia* ***Boris Vaňo*** – *Demographic Research Centre, Institute of Informatics and Statistics, Slovakia*
9:50-10:10 10	.2	♦ The problematic of population projections in small island states: the case of Cape Verde ***Pedro Moreno de Brito*** – *Universidade Nova de Lisboa, Portugal* ***Teresa Rodrigues*** – *Institute of Statistics and Information Management Systems, Portugal*
Paper not presented	10.3	♦ Using national data to obtain small area estimators for population projections on sub-national level ***Michael Franzén, Therese Karlsson*** – *Statistics Sweden*
10:10-10:30		Questions & Discussion
11:00-11:20 10	.4	♦ Austrian Regional Population Projections below NUTS-3 ***Alexander Hanika*** – *Statistics Austria*
11:20-11:40 10	.5	♦ Sub-national and foreign-born population projections: the case of Andalusia ***Juan Antonio Hernández, Silvia Bermúdez, Joaquín Planelles*** *Instituto de Estadística de Andalucía, Spain*
11:40-12:00		Questions & Discussion
14:00-16:30 1	**1**	**BEYOND POPULATION PROJECTIONS BY AGE AND SEX** **Chair: Jorge Miguel Bravo** - Universidade de Évora, Portugal
14:00-14:20 11	.1	♦ Projections of religiosity for Spain ***Marcin Stonawski, Vegard Skirbekk, Samir KC, Anne Goujon*** *International Institute for Applied Systems Analysis, Austria*
14:20-14:40 11	.2	♦ New projections of the ethnocultural composition of the Canadian population using Demosim microsimulation model ***Éric Caron Malenfant, Laurent Martel, André Lebel*** – *Statistics Canada*
14:40-15:00		Questions & Discussion
15:30-15:50 11	.3	♦ Tertiary education enrolment trends and projections in Latvia ***Zane Cunska*** – *University of Latvia*
15:50-16:10 11	.4	♦ Projecting race and Hispanic origin in the U.S. population projections and an examination of the impact of net international migration ***David G. Waddington, Victoria A. Velkoff*** – *U.S. Census Bureau*
16:10-16:30		Questions & Discussion
		END OF DAY 2

Time	Item	Session/Activity
		DAY 3 – FRIDAY 30 April 2010
		– CONFERENCE ROOM 1 –
9:30-12:00 12		**STOCHASTIC TECHNIQUES FOR DEMOGRAPHIC PROJECTIONS** **Chair: Jutta Gampe** – Max Planck Institute for Demographic Research Rostock, Germany
9:30-9:50 12	.1	♦ Combining deterministic and stochastic population projections ***Salvatore Bertino, Eugenio Sonnino*** – *University of Rome "La Sapienza", Italy* ***Giampaolo Lanzieri*** – *European Commission, Eurostat*
9:50-10:10 12	.2	♦ A mate-matching algorithm for continuous-time microsimulation models ***Sabine Zinn*** – *Max Planck Institute for Demographic Research Rostock, Germany*
10:10-10:30 12	.3	♦Bayesian population forecasts for England and Wales ***Guy Abel, Jakub Bijak, Jonathan Forster, James Raymer, Peter Smith*** - *University of Southampton, United Kingdom*
10:30-11:00		Questions & Discussion
11:30-11:50 12	.4	♦Practical population forecasting by microsimulation: application of the MicMac software ***Ekaterina Ogurtsova, Jutta Gampe, Sabine Zinn*** – *Max Planck Institute for Demographic Research Rostock, Germany*
11:50-12:00		Questions & Discussion
12:00-13:00	**13**	**STOCHASTIC NATIONAL DEMOGRAPHIC PROJECTIONS** **Chair: Jutta Gampe** – Max Planck Institute for Demographic Research Rostock, Germany
12:00-12:20 13	.1	♦ Immigration, ethnocultural diversity and the future composition of the Canadian labour force ***Alain Bélanger*** – *Institut National de la Recherche Scientifique, Canada* ***Nicolas Bastien*** – *Centre Urbanisation Culture Société, Canada*
12:20-12:40 13	.2	♦ Developing stochastic population forecasts for the United Kingdom: Progress Report and plans for future work ***Emma Wright, Steve Rowan*** – *Office for National Statistics, United Kingdom*
12:40-13:00		Questions & Discussion
14:30-15:30 1	**4**	**ROUND TABLE DISCUSSION** **Chair: Maria Filomena Mendes** – Portuguese Demographic Association ♦ Is it necessary, and to what extent, to incorporate "feedback mechanisms" in demographic projections, in particular in population projections? ***Michel Poulain*** – *Université Catholique de Louvain, Belgium* ***Graziella Caselli*** – *University of Rome "La Sapienza", Italy* ***Jutta Gampe*** - *Max Planck Institute for Demographic Research Rostock, Germany* ***Jorge Miguel Bravo*** – *Universidade de Évora, Portugal* ***Vanda Cunha*** – *Ministry of Finance and Public Administration, Portugal*
16:00-16:15	**15**	**PROPOSALS FOR FUTURE WORK** Eurostat and UNECE
16:15-16:30	**16**	**Adoption of the report**
16:30		**CLOSING OF THE WORK SESSION**

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SESSION 12: STOCHASTIC TECHNIQUES FOR DEMOGRAPHIC PROJECTIONS

SESSION 13: STOCHASTIC NATIONAL DEMOGRAPHIC PROJECTIONS

EXPLANATIONS FOR REGIONAL FERTILITY REVERSAL AFTER 2005 IN JAPAN: DEMOGRAPHIC, SOCIO-ECONOMIC AND CULTURAL FACTORS

Miho IWASAWA[1], Ryuichi KANEKO[1]

Abstract

The major goal of this paper is to explore the explanations for the total fertility rate (TFR) upturn in Japan after 2005[2]. Following the view on the retreat from lowest-low fertility in European countries (Castiglioni and Dalla Zuanna 2008, Goldstein, Sobotka and Jasilioniene, 2009), we focus on possible factors such as elimination of tempo effects, increase of foreign mothers, improvement of the economic condition, and policy improvement on work-family reconciliation. Using weighted least squares models or weighted spatial error models, we estimate the influence of these factors on prefecture (state)-level TFR change from 2005 to 2008 by birth order. Our results suggest that the TFR upturn is mostly explained by increase in late fertility. While increase in foreign mothers and decline in unemployment rates also pushed TFR upward, change in maternal labor force participation was negatively associated with the TFR change. Cultural factor also explains the TFR variations. The higher proportion of extended family households contributes to fertility increase in third and higher birth order, but this relationship was not observed for lower-order fertility.

1. Introduction

Rapid population change due to extremely low birth rate has a significant impact on future societies, thus great attention has been paid to understand current fertility trend for plausible population projections. In the past, most population projections hold the assumption that the post-transitional fertility would eventually stay close to the replacement level (Bongaarts 2002). Today, many of the official population projections including the United Nation's projection[3], however, consider such assumption unrealistic. These projections assume that very low fertility will continue for a while, especially for countries with extremely low fertility rates (total fertility rate (TFR) less than 1.3) (UN 2008, Moriizumi 2008). Kohler and his colleagues (2002) suggest the possibility of these nations, what they call the nations with "the lowest low fertility," remaining the same for several decades. Despite such pessimistic view, since the latter half of the 1990s, the fertility rates showed some recovery in Italy and Spain, two of the title holders of the lowest low fertility. Other lowest-low fertility nations in Central Europe, Eastern Europe, and East Asia also showed such recovery in fertility since 2000. In Japan, the TFR appears to recover after it reached the record low of 1.26 in 2005. In 2008, the TFR was 1.37 and expected to remain the same level in 2009 (MHLW 2009) (see Figure 1).

Currently, various scholars introduced new perspectives to understand nations with the lowest-low fertility (Castiglioni and Dalla Zuanna 2008, Billari 2008, Goldstein, Sobotka and Jasilioniene 2009, Caltabiano, Castiglioni and Rosina 2009). These scholars focused on the fertility upturn in Europe, thus

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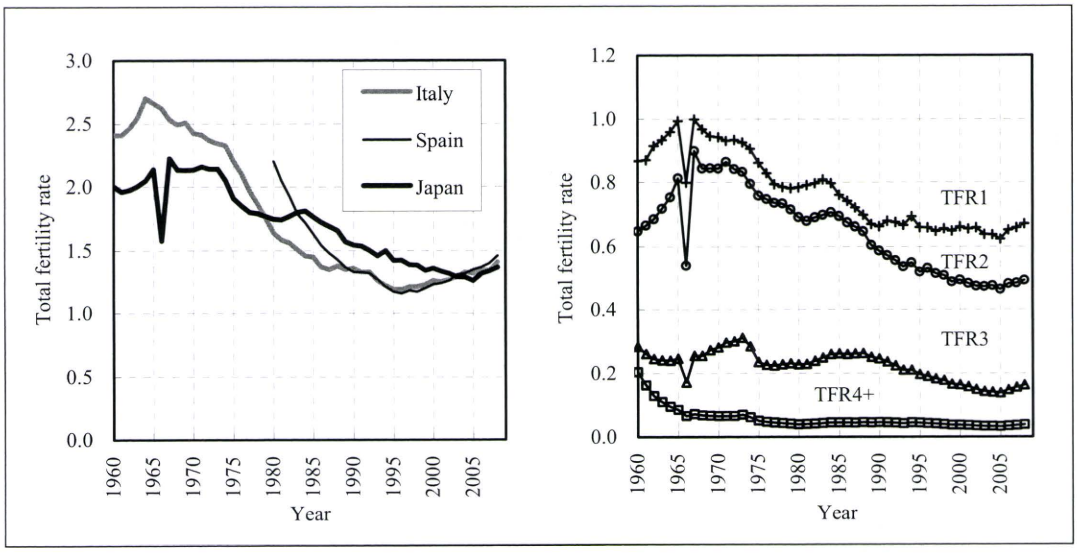
[1] National Institute of Population and Social Security Research, Tokyo, Japan

[2] This project is contributed by Kenji Kamata, National Institute of Population and Social Security Research (Tokyo, Japan), and James M. Raymo and Kimiko Tanaka, University of Wisconsin at Madison (United States).

[3] The medium-variant fertility assumption used for the United Nation biannual population projection in 1996 states that nations experiencing below the replacement fertility rates will recover to the replacement level of 2.1 in 2050. In the projections in 1998, however, the assumption was changed stating that fertility would only recover to 1.8 by 2050. In 2008, it is assumed that nations with current TFR below 1.85 will not possibly return to the same level even in 2050 (UN 1996, 1998, 2008).

whether the explanation of fertility upturn is applicable to other regions is questionable. Our paper aims to explore factors influencing the recent fertility upturn in Japan. Specifically, we asked whether factors explaining the fertility upturn in Europe (Castiglioni and Dalla Zuanna 2008, Goldstein, Sobotka and Jasilioniene 2009) are applicable to explain the fertility upturn in Japan. To answer this question, we estimated ecological regression models explaining variation of prefecture (state)-level TFR change since 2005.

Figure 1. Total fertility rate in Japan, Italy an d Spain (left) and birth-order-specifi c total fertility rates in Japan (right), 1960 ~ 2008



Source: Japan: Vital Statistics (Statistics and Information Department, Minister's Secretariat, Ministry of Health, Labour and Welfare). Italy: UN, Demographic year book, Eurostat database, ISTAT (2008). Spain: UN, Demographic year book, Eurostat database.

2. Total Fertility Rate Upturn in Lowest-low Fertility Countries

Since the latter half of the 1990s, surprisingly some European and Asian nations with lowest low fertility (TFR below 1.3) experienced fertility upturn. Various scholars offered explanations to understand the fertility upturn, mainly in southern European nations.

Castiglioni and Dalla Zuanna (2008) analyzed the TFR reversal observed in Italy in the latter half of the 1990s. They claimed that the fertility upturn is observed in northern Italy and other economically developed areas where new family formation behaviours discussed in the Second Demographic Transition (SDT) such as legal separations and extramarital childbirth are prominent. Such a significant fertility upturn was not observed in southern Italy where strong traditional family norms contributed to high fertility rates in the past (Castiglioni and Dalla Zuanna 2008). Billari (2008) pointed out that the rapid increase of foreign population in Italy and Spain also contributed to recent increase in fertility rates.

Goldstein and his colleague (2009) showed that some recovery from lowest-low fertility was also observed in Central Europe, Eastern Europe, and East Asia. Their analyses suggested that a decline in the tempo effect—driven by the slowdown of postponement visible in women's mean age at birth, and dramatic increase in immigrants explain certain increase of the TFR in some areas (e.g. Spain). Based on the temporal correlation between unemployment rates and total fertility rates, they also suggested that economic recovery may have contributed to the fertility recovery.

Although further studies are necessary, they concluded that expansion of work and family reconciliation policies is likely to lead to recovery of fertility rates (Goldstein, Sobotka and Jasilioniene 2009).

In our study, we focus on the factors Goldstein and his colleagues used to explain fertility upturn in their cross-national study. They are: (1) diminishing tempo effects, (2) increase in foreigners, (3) economic improvement, and (4) policy improvement on work and family reconciliation. In addition, we also looked at the influence of family culture. The study by Castiglionin and Dalla Zuanna (2008) suggested the association between fertility decline and family culture where traditional gender norms are emphasized. Since Japan shares the similar family culture with Italy where families play a central role in caring for their family members rather than relying on public services, we find it important to include it as an additional factor to explain variation in fertility change in Japan.

Besides the fact that most studies have focused on studying fertility upturn in Western European nations, there are several advantages in studying fertility upturn in Japan in terms of the data quality. First, official register-based statistics maintained in time-series are available from prefectural-level data sources. Second, since immigration controls in Japan are relatively reliable, highly accurate data set is available on international migration. Moreover, racial diversification is relatively small compared with other industrialized nations. In fact, foreign national including immigrants count for 1.4 percent of the total population in 2008, which allows for simple models that does not take into account racial heterogeneity.

3. Method

We estimate weighted least squares models (WLS) and weighted spatial error models (WSE), and select the more appropriate model for explaining prefecture-level variation in TFR change.

The unit of our analysis is geographically associated aggregated data. Geographically referenced data often show spatial autocorrelation. Spatial autocorrelation refers to a situation in which values on a variable of interest are systematically related to geographic location. Thus, if an ordinary least-square regression model that assumes the error terms to be independently, identically, and normally distributed is used without taking the existence of spatial autocorrelation among residuals, the standard errors of the regression coefficient estimates can be underestimated or overestimated (Chi and Zhu 2008).

For this reason, our study not only estimates an ordinary least squared model but also estimates a spatial error model which explicitly models spatial autocorrelation of such error terms, and select the more appropriate model in terms of model fitness and significance of the spatial autoregressive coefficients of the models. A spatial error model is specified as follows (Anselin 1988, Ward and Gleditsch 2008):

$$
\begin{aligned}
y &= X\beta + u, \\
u &= \lambda W u + \varepsilon, \\
\varepsilon &\sim N\left(0, \sigma^2 I\right)
\end{aligned}
$$

where y is a (n x 1) vector representing the dependent variables, X is a (n x k) matrix representing the k-1 independent variables, β is a (k x 1) vector of regression parameters to be estimated, u is a (n x 1) vector of error terms presumed to have a covariance structure as given in the second equation, λ is a spatial autoregressive coefficient to be estimated, W is a (n x n) weight matrix defining the "neighbourhood" structure that reflects the potential interaction between neighbouring locations and zeros out pairs of locations for which spatial correlation is ruled out a priori, and ε is a (n x 1) vector of independently distributed (spatially uncorrelated) errors (i.i.d.). We used a first-order queen convention to define neighbours for the weight matrix used in estimating spatial regression model.

In Japan, population size varies significantly among prefectures. For example, the population of Tokyo is 12 million, by contrast Tottori prefecture has only 600, 000 citizens, approximately a twentieth of the population in Tokyo. Since the variables we use, which will be mentioned in the next section, are mostly related to behaviours among women of reproductive ages, we used female population in reproductive ages (15 – 49 years of age) in each prefecture for weights.

We used "spdep" package in the open source programming language R for model estimations. The selected model is used to examine the association between explanatory variables and fertility upturn by predicting the national values in fertility change after 2005 and showing the contribution of each factor to fertility increase.

4. Data and Variables

For the dependent variables, the change of all-birth TFR and the change in birth-order-specific TFR by prefecture from 2005 to 2008 are used.

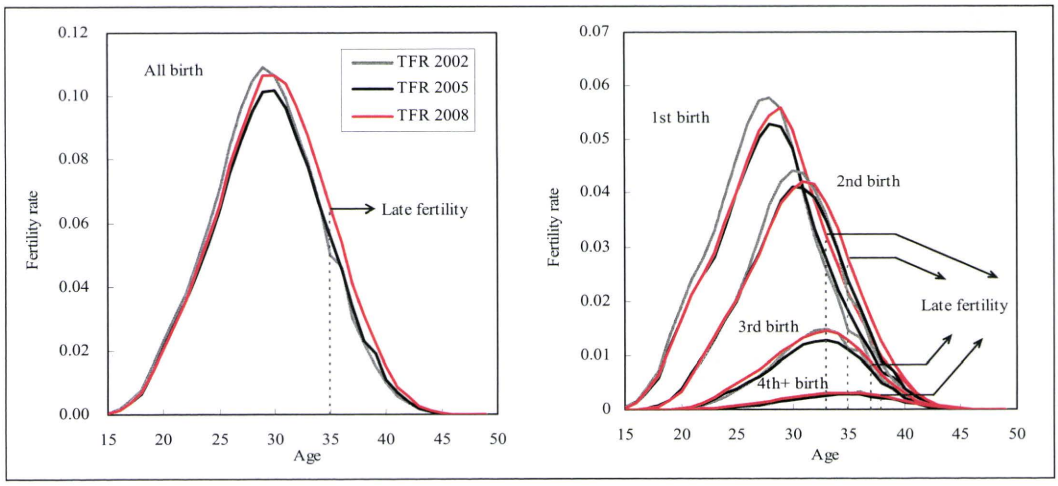
For the explanatory variables, we used four factors Goldstein and his colleagues (2009) focused on to explain fertility upturn in their cross-national study (diminishing tempo effects, increase in foreigners, economic improvement, and policy improvement on work and family reconciliation) and also used a contextual factor reflecting family culture.

4.1 Diminishing Tempo Effect: Change in Late Fertility

Tempo effects are caused by postponement of childbearing. If the postponement trend visible in women's mean age at birth stops, the tempo effects observed in the past are expected to diminish. Under this circumstance, women who postponed childbearing in their 20s start to catch up in their 30s or later. Thus we expect that diminishing tempo effects would be accompanied by fertility increase in the 30s.

In our study, diminishing tempo effect was measured as increase in "late fertility." For simplicity, we assume that late fertility accounts for approximately 20% of the total. Late fertility is thus defined as fertility at 35 years old or over for all births (which accounts for 18.1% of the total fertility rate as of 2008), 33 years old or over for the first births (20.6%), 35 years of age or over for the second births (20.2%), 36 years old or over for the third births (22.6%), and 38 years old or over for the fourth and higher-order births (22.4%) (see Figure 2). For the variable, we used the change in fertility rate limited to these ages from 2005 to 2008.

Figure 2. All birth an d birth orde r-specific ag e-specific birth rates - 2002, 2005, 2008



Source: Vital Statistics (Statistics and Information Department, Minister's Secretariat, Ministry of Health, Labour and Welfare).

4.2 Increase in Foreigners: Change in Fertility Rate by Foreign Mothers

The period TFR provided officially by the Ministry of Health, Labour and Welfare are calculated for new born children with Japanese nationality. The calculation does not include children born to foreign couples living in Japan but includes children whose mothers are foreign who married to Japanese men[4], because these children have Japanese nationality. Nonetheless, the female population used as the denominator is limited to Japanese women, and their foreign mothers are not included[5]. This invites an increase of the total fertility rate through a structural factor of an increasing number of foreign women giving birth to Japanese children, even if the actual fertility of Japanese women remains unchanged.

In Japan, the percentage of international marriages has been increasing from the late 1990s. The percentage of marriages where wives are foreign accounts for 2.8% of total number of marriages in 1990, which increased to 4.6% in 2005. Since the female population used as the denominator is limited to Japanese women, an increasing number of foreign women giving birth to Japanese children may be causing recent fertility upturn. In other words, we expect prefectures where increase in foreign mothers is observed to be positively associated with fertility change.

In our study, the influence of increase in foreign mothers is measured as change in TFR "inflated" by foreign mothers. Specifically, we use change from 2005 to 2008 in TFR contributed by foreign mothers (TFR x percentage of births born to foreign mothers)[6].

4.3 Economic Improvement: Change in Employment Rate

In Japan, the unemployment rate has been falling since around 2004. Since it was followed by upturn in TFR, improvement in economic condition is likely to play a role in the recovery of the fertility rate. In other words, the association between prefectures with economic improvement and fertility change is expected to be positive.

In our study, using the Labour Force Survey, economic improvement was measured by change in employment rate (complementary number of the unemployment rate) by prefecture. Since there expected to be a time lag for the recovery from unfavourable economic conditions to influence fertility, we looked at change in employment rate from 2002 to 2007.

4.4 Policies on Work and Family Reconciliation: Change in Labour Force Participation Rate among Mothers hav ing Preschool Children Living in Nuclear Family

Family policies variation across space can help us study the effect of such policies on fertility (Neyer and Anderson 2008). Japanese government has been promoting the work and family reconciliation programs as part of policy initiatives aiming to stimulate higher fertility since 2000 as represented by "New Angel Plan" (Ogawa 2003, Moriizumi 2008)[7]. From 2005 to 2009, the "Children and Childcare Plan" was established, instead of the "New Angel Plan."

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4 In Japan, nationality is difficult to receive even foreign mothers married to Japanese men.

5 Definition of total fertility rate in the Vital Statistics is as follows:

Total fertility rate = Sum for ages (15-49) [(Number of births born to Japanese mothers) + (Number of children with Japanese nationality born to foreign mothers*)]/ (Population of Japanese females). *This refers to a child whose father has Japanese nationality.

6 Since the number of births by mother's nationality is not available by birth order, we used the percentage of births born to foreign mothers out of the total number for the birth-order specific TFR as well.

7 In addition to the "New Angel Plan" in 2000 to 2004 (reinforcement of child-rearing services, improvement of employment environment for reconciliation of work and family life, correction of corporate climate whereby gender division of labour and priority on workplace are taken for granted), the Zero Children on Waiting List Strategy was started in 2001 for the purpose of building up sufficient child-care centers. In 2003, the Law for Measures to Support the Development of the Next Generation (promotion of concentrated and systematic measures of 10 years by municipalities and corporations) was formulated.

There are improvements in the benefits of child-care leave and implementation of the After-school Childcare plan (securing places of activity for children after school in all elementary school zones).

In 2007, the "Action Agenda for Promoting Work-life Balance" was resolved as a priority task of the "Strategies for Japan to Support Children and Families." More importantly, after 2005, each municipality is obliged to take its own measures according to its action plans based on the Law for Measures to Support the Development of the Next Generation. This might have caused differences in the progress of policies of reconciliation of work and family life depending on the region. In other words, we expect to see a positive effect on prefectures with better family policies on fertility upturn since more women will give a birth in areas where they have more supportive policies for women to balance between work and family.

There are no established measurement for the effectiveness of policies on family and work. In our study, we measured the effectiveness of policies on family and work by the change in the employment rate of mothers. Improvement in public services and corporations regarding reconciliation of work and family life are considered to bring about larger effects among mothers of nuclear families who cannot easily receive support from relatives such as grandmothers/fathers. Thus we focus on mothers of nuclear families with children under 6 years of age. We use the change in their employment rate between 2002 and 2007, obtained from the Employment Status Surveys for each prefecture conducted in 2002 and 2007.

4.5 Family culture: Proportion of extended families among households including pre-school children

As in Italy, there are regional differences in family systems in Japan. Ohbayashi (1996) classified the regionality of social organizations, and claimed that paternalistic family organizations played important decision-making roles in northern part of Japan (Tohoku Region) (Ohbayashi 1996). On the other hand, in western Kyushu, coastal Shikoku, Hokuriku, and coastal Tokai, the village organizations had more important decision-making roles than family organizations (Ohbayashi 1996). Therefore, there are variations in family culture across regions as in Italy. According to Kato (2008), pattern of living arrangement reflects the strength of family culture. In eastern regions with strong family culture, historically an older couple (parents) and a younger couple (son and daughter-in-law) co-reside in a single household. In contract, in western Japan, a parent couple lives in an independent household from children's family, usually on the same lot.

In our study, we measured strength of family culture by the prevalence of extended family households. Based on the 2005 census, we calculated the proportion of the extended family among households including children of less than six years of age in each prefecture. As such a characteristic does not change in the short term, we include it in our model as a fixed effect. We expect to see negative relationship between prefectures with strong family culture and fertility change as in the case of Italy.

4.6 Model

The model used to examine each effect of elimination of tempo effects, inflation by foreign mothers, economic improvement, policies on work and family reconciliation, and family culture can be expressed as follows. Δ represents difference.

$$\Delta TFR\ (2005\text{-}2008) = \text{Constant} + \Delta\ \text{Late fertility}\ (2005\text{-}2008) + \Delta TFR\ \text{inflated by foreign mothers}\ (2005\text{-}2008) + \Delta\ \text{Employment rate}\ (2002\text{-}2007) + \Delta\ \text{Labour force participation rate among mothers having preschool children living in a nuclear family}\ (2002\text{-}2007) + \text{Proportion of extended families among households including preschool children (fixed effect)}\ (2005)$$

We fit this model to the data for all-birth TFR and birth-order specific TFR using weighted least squares regression (WLS) and weighted spatial error regression (WSE).

5. Results

5.1 Descriptive statistics

Table 1 shows descriptive statistics of variables we used in the analysis. The values of Moran's I[8] suggest that all of the dependent variables are spatially auto-correlated. For explanatory variables, the following factors showed significant spatial autocorrelation: change of late fertility for all-birth fertility, first birth fertility and fourth and higher-order fertility, change of fertility inflated by foreign mothers for all-birth and all birth-order-specific births, change of employment rate, and proportion of extended family.

Table 1. Descriptive statistics for variables used in the analyses

	Variable			Period of change	Source	National-level value	Prefecture-level data (N=47) Weighted Mean[5]	Min	Max	Spatial autocorrelation Moran's I[5]
Dependent variables	Change in TFR		All birth	2005-08	Vital Statistics [3]	0.1069	0.1051	0.0089	0.1628	0.343 ***
			1st birth	2005-08	Vital Statistics [3]	0.0472	0.0470	-0.0275	0.0818	0.304 **
			2nd birth	2005-08	Vital Statistics [3]	0.0291	0.0281	-0.0186	0.0470	0.252 **
			3rd birth	2005-08	Vital Statistics [3]	0.0242	0.0237	-0.0116	0.0429	0.136 #
			4th + birth	2005-08	Vital Statistics [3]	0.0064	0.0063	0.0003	0.0182	0.494 ***
Explanatory variables	Change in late fertility	age 35+	All birth	2005-08	Vital Statistics [3]	0.0459	0.0435	0.0108	0.0575	0.189 *
		age 33+	1st birth	2005-08	Vital Statistics [3]	0.0248	0.0234	0.0087	0.0350	0.427 ***
		age 35+	2nd birth	2005-08	Vital Statistics [3]	0.0190	0.0180	0.0054	0.0269	0.006
		age 36+	3rd birth	2005-08	Vital Statistics [3]	0.0056	0.0069	-0.0006	0.0126	0.003
		age 38+	4th + birth	2005-08	Vital Statistics [3]	0.0011	0.0011	-0.0036	0.0037	0.222 *
	Change in TFR inflated by non-Japanese mothers		All birth	2005-08	Vital Statistics [3]	0.0020	0.0019	-0.0047	0.0085	0.406 ***
			1st birth	2005-08	Vital Statistics [3]	0.0009	0.0009	-0.0024	0.0042	0.422 ***
			2nd birth	2005-08	Vital Statistics [3]	0.0006	0.0006	-0.0020	0.0029	0.383 ***
			3rd birth	2005-08	Vital Statistics [3]	0.0004	0.0003	-0.0005	0.0011	0.329 ***
			4th + birth	2005-08	Vital Statistics [3]	0.0001	0.0001	-0.0001	0.0003	0.368 ***
	Change in employment rate			2002-07	Labour Force Surveys [4]	0.0150	0.0155	-0.0010	0.0270	0.284 **
	Change in labor force participation rate among mothers having preschool children [1]			2002-07	Employment Status Surveys [4]	0.0554	0.0556	-0.0066	0.1636	-0.051
	Proportion of extended families [2]			2005	Census [4]	0.1878	0.1839	0.0789	0.5011	0.379 ***

*** p<.001 ** p<.01 * p<.05 # p<.1

1) For mothers of in nuclear families

2) For households including preschool children

3) Statistics and Information Department, Minister's Secretariat, Ministry of Health, Labour and Welfare

4) Statistics Bureau, Ministry of Internal Affairs and Communications

5) Reproductive age female population (15-49) in 2005 is used as a weight.

[8] Moran's I statistic measures the degree of linear association between an attribute (y) at a given location and the weighted average of the attitude at its neighbouring locations (Wy), and can be interpreted as the slope of the regression of (Wy) on (y) (Cliff and Ord 1973, Moran 1950). As for the spatial weight matrix to specify a neighbourhood structure, we use queen's case contiguity weight matrix of order one, as well as for the spatial regression analyses.

5.2 Model estimations

Weighted least squares (WLS) models and weighted spatial error (WSE) models are estimated for all-birth and birth-order specific TFR (first, second, third, and fourth and higher-order births). Model coefficients and diagnosis for spatial autocorrelation among model residuals are shown in Table 2 (first, second, and third birth model only).

For change in the first-order TFR, the following four variables were significant in both WLS and WSE models: changes in late fertility (+), fertility inflated by foreign mothers (+), employment rate (+), and mothers' employment rate (+).The directions of the effect of late fertility rate, fertility rate inflated by foreign mothers, and employment rate were expected. However, the change of mothers' employment rate had unexpected negative effect. The constant is negative, but insignificant suggesting that there was no common effect.

For change in the second-order TFR, the late fertility rate (+), change of fertility rate inflated by foreign mothers (+), and proportion of extended families (-) are statistically significant in both WLS and WSE models. The direction of each coefficient is as we expected. The constant is positive, but insignificant.

For change in the third-order TFR, the effects of change in late fertility rate (+) and proportion of extended families (+) are statistically significant in both WLS and WSE models. Unlike second-order TFR, the effect of the proportion of extended families is positive, which implies that prefectures with higher proportion of extended families have higher increase in third birth fertility. The constant is positive and significant, suggesting overall common positive effect regardless of explanatory variables.

As for the fourth and higher-order birth model, the effects of changes of late fertility (+), fertility inflated by foreign mothers (+), and mothers' employment rate (-) are statistically significant factors. As in the case of third birth, the proportion of extended families are positive and statistically significant. The constant is also positive and significant.

For change in the TFR for all births, the effects of changes in late fertility (+), fertility inflated by foreign mothers (+), and mothers' employment rate (-), and the proportion of extended families (-) are statistically significant. Although the constant is positive, it is not significant.

According to the Lagrange Multiplier test for spatial autocorrelation, as for the first and third birth models, the WLS models fit better than the WSE models; for all-birth, second birth, and fourth and higher-order birth models, the WSE models specifying autocorrelation among residual of neighbouring prefectures fit better than the WLS models (see Table 2).